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Numerical modelling of microphysical and optical characteristics of frontal stratiform clouds

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This work is based on the microphysical model of frontal clouds, which the authors developed earlier, and is devoted to numerical simulation of microphysical and optical properties of frontal mixed clouds in which ice crystals of several different forms coexist. The special attention is given to the analysis of such optical characteristics as a cloud optical thickness (COT) and cloud reflectance (CR) of solar radiation in visible and near infrared area of a spectrum.

Simulation of dependence of cloud optical characteristics on phase composition has shown:

1) in case of thick clouds with high cloud top, where cloud top temperature (CTT = -34˚C and more low) only mixed and mainly crystal (ice) clouds are formed. CR value areas for these two gradations (both for $\lambda 1$ = 0.55 mkm and for $\lambda 3$ = 1.6 mkm) do not overlap, whereas COT values overlap considerably. COT values are insignificant (ranges of values 9 – 35) in such clouds;

2) in case of clouds with low cloud top, where CTT > -23˚C, clouds of all three gradations (mainly liquid-drop, mixed, mainly ice) can be formed. Mainly liquid-drop clouds can have very big optical thickness (to 200 and more). CR ranges also do not overlap for different gradations; especially big discrepancy in CR values (at $\lambda 3$ =1.6 mkm) is available between gradation of mainly liquid-drop clouds and the sum of gradation of mixed and mainly ice clouds.

Results of modelling of relations COT ($\lambda 3$) / COT ($\lambda 1$) show that:

a) for mainly liquid-drop clouds: (COT ($\lambda 3$) / COT ($\lambda 1$)) $\geq$1.04;

b) for the mixed clouds: 1.04 > (COT ($\lambda 3$) / COT ($\lambda 1$)) $\geq$1.01;

c) for mainly ice clouds: 1.01 > (COT ($\lambda 3$) / COT ($\lambda 1$)) $\geq$1.

The results can be useful as criteria for determining the phase composition of the cloud areas.

Reference

B.A.Dorman, V.P.Bakhanov, O.Y.Manzhara:
Microphysical and optical characteristics of frontal mixed clouds (results of numerical simulation)
Trudy UHMI; 2010; №259; 74-90; (in Russian).